

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD  
ARIZONA**

**PUMPING PLANT  
(No.)**

**CODE 533**

**DEFINITION**

A facility that delivers water at a designed pressure and flow rate. Includes the required pump(s), associated power unit(s), plumbing, appurtenances, and may include on-site fuel or energy source(s), and protective structures.

**PURPOSE**

This practice may be applied as a part of a resource management system to achieve one or more of the following:

- Delivery of water for irrigation, watering facilities, wetlands, or fire protection
- Removal of excessive subsurface or surface water
- Provide efficient use of water on irrigated land
- Transfer of animal waste as part of a manure transfer system
- Improvement of air quality
- Reduce energy use

**CONDITIONS WHERE PRACTICE APPLIES**

This practice applies where conservation objectives require the addition of energy to pressurize and transfer water for any of the following purposes:

- To maintain critical water levels in soils, wetlands, or reservoirs;
- To provide a water supply for such purposes as irrigation, recreation, livestock, or wildlife.
- To transfer wastewater for utilization as part of a waste management system; or
- To provide drainage by the removal of surface runoff or groundwater.

**CRITERIA**

**General Criteria Applicable to All Purposes**

*Pumping plant facilities shall be designed on an individual basis to meet site conditions and functional requirements. They shall be part of an approved and overall engineering plan for*

*irrigation, drainage, livestock, wildlife, recreation, channel improvement, or similar purposes.*

*Design and implementation of subsidiary components and/or structures shall meet all applicable Natural Resource Conservation Service (NRCS) conservation practice standards. The criteria for the design of any components not specifically addressed in NRCS practice standards or specifications shall be consistent with sound engineering principles and/or manufacturer recommendations.*

*All pertinent safety codes (OSHA, ADOSH) and manufacturer's recommendations shall be followed in the installation and operation of the equipment.*

**Laws and Regulations.** *Design, installation, and operation of a pumping plant shall comply with all federal, state, Tribal and local laws, rules, and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.*

*The owner is responsible for securing necessary permits and water rights, complying with all laws and regulations, and meeting legal requirements applicable to the installation, operation, and maintenance of this practice and associated structures.*

**Pump requirements.** *Design flow rate, range of operating heads, and pump type shall meet the requirements of the application. The pump must be capable of delivering the design water requirements (Q) at the total dynamic head (TDH). Total dynamic head shall be determined for critical operating conditions, taking into account all hydraulic losses. Automatic controls shall be included as required.*

*Selection of pump type and materials shall be based on the physical (consistency) and chemical qualities of the material being pumped and manufacturer's recommendations.*

*Pumps utilized for the transfer of wastewater or manure shall be sized to transfer material at the required system head and flow rate determined by the waste management plan.*

**Power units.** Pump power units shall be selected based on the availability and cost of power, operating conditions, need for automation, and other site specific objectives. Power units shall match the pump requirements and be capable of operating efficiently and effectively within the planned range of conditions. The power unit shall be sized to meet the horsepower requirements of the pump, including efficiency, service factor, and environmental conditions.

Electric power units may include line power, photovoltaic panels, and wind or water powered turbines.

*All electrical work and wiring shall meet the requirements of the National Electrical Code (NEC) and be installed in accordance with current standards of the National Electrical Manufacturer's Association (NEMA), the Underwriters Laboratory, INC. (UL) and applicable State of Arizona, Tribal and/or county regulations. All electrical equipment, including electrical motors and panels, shall be grounded*

**Variable Frequency Drives.** *Variable Frequency Drives (VFD's) shall be installed to promote energy savings, namely in (1) constant pressure/head - variable flow, (2) constant flow – variable pressure/head, or (3) variable flow – variable pressure/head conditions. The owner shall inform the electric power provider that a Variable Frequency Drive will be installed prior to installation, and be responsible for following requirements of the electric power provider.*

*Manufacturer recommendations shall be used to determine the VFD selection based on load requirements (pressure and flow), motor selection, system operation efficiency and power factor (amperage and voltage characteristics), along with site specific conditions or limitations. VFD components, electronics, equipment and installation shall meet the following minimum requirements:*

- *The VFD shall be a Six Step Inverter (variable voltage source), Current Source Inverter, or a Pulse Width Modulated Inverter (constant voltage source)*

- *Shall be rated at 15 percent more horsepower than the specified motor horsepower to minimize voltage distortion and interference;*
- *An isolation motor contactor shall be installed, to provide a bypass during emergency situations and to protect the drive from irregularities in the line voltage;*
- *For drives connected to three phase supply, a line filter shall be installed to regulate the voltage;*
- *The Variable Frequency Drive shall be protected against overheating. Adequate sunshades or pump houses are required for all installations meeting minimum manufacturer recommendations for environmental considerations;*
- *If the ambient air temperature exceeds 104°F, then the VFD shall be cooled by an external heat sink or self-contained cooling system;*
- *Must be installed in an enclosure meeting NEMA 4 standards, for protection from dust and water;*
- *Soft start/stop capability and acceleration/deceleration protection;*
- *The Variable Frequency Drive control panel shall provide the read out display of flow rate or pressure.*

*Manufacturer's literature shall include installation and operating instructions, wiring diagrams, schematics, spare parts lists, warranty documentation, maintenance requirements and any other information that is normally supplied with individual components. Manufacturer and/or installer shall provide a schematic of the entire operating system, including wiring and control components prior to implementation.*

*If the source of water is a well, the well depth, yield, static water level, draw down level at the design pumping rate shall be obtained either from a well production test or from well records, if available. Arizona Department of Water Resources, Pump Installation Completion Report, AZ Standard drawings, or other documentation used by local regulatory agency shall be used to document this practice.*

**Photovoltaic panels.** The photovoltaic (PV) array (module size and number) shall be sized based on the pump amperage and voltage requirements, motor selection, system operation efficiency and power factor (amperage and

voltage characteristics), and the average data for the location and the time of year pumping occurs, according to manufacturer's recommendations. PV panels, modules, components, electronics, equipment and installation shall meet the following minimum requirements:

- The photovoltaic array shall provide the power necessary to operate the pump at the design flow rate (daily water requirements) at the specified operating, with the appropriate service factor considering a minimum panel degradation of 10 years.
- Fixed arrays shall be oriented to receive maximum sunlight and panel tilt angle shall be based on the location latitude and time of year for power requirements.
- Module seals shall remain watertight between -20°F to 120°F;
- The PV modules and panels shall be mounted securely to resist movement by environmental factors and shall be anchored to resist overturning from wind loads (80 mph) and ice loading of 1-inch thick on all exposed surfaces.
- PV modules and panels may be fenced to prevent damage from livestock or wildlife.

Solar trackers or storage battery units may be included as components of a PV powered pumping plant. The batteries, battery closure, charge controller and wiring design should be in accordance with the manufacturer's recommendations and NEC articles 300, 480 and 690.

In lightning prone areas, consider locating the PV system away from high points in the topography, installing lightning rods adjacent to the system, or including lightning surge protection in the system specifications. Manufacturer's literature shall include installation and operating instructions, wiring diagrams, schematics, spare parts lists, warranty documentation, maintenance requirements and any other information that is normally supplied with individual components. Manufacturer and/or installer shall provide a schematic of the entire operating system, including wiring and control components prior to implementation.

**Windmills.** Windmill shall be a new Dempster, Aeromotor, American West, or an approved equal. Pumping units shall be sized according to pumping lifts and capacities, as specified by the manufacturer. In the absence of manufacturer

criteria, the following minimum standards shall apply:

- Mill shall be self-oiling with replaceable bearings;
- Pump or sucker rod shall be a ¾-inch, hollow or solid, galvanized steel rod or a 5/8-inch fiberglass rod with integral couplings. Pump rod couplings shall be offset from the column pipe or drop pipe couplings;
- Drop pipe shall consist of threaded galvanized pipe meeting ASTM A53 or as specified by the manufacturer;
- The well cylinder assembly shall be an open-top, brass-lined galvanized or brass cylinder and shall include a three or four leather plunger with a single or double leather check, both with matching stainless steel or brass ball valves;
- An automatic bleeder orifice valve shall be installed in the drop pipe within 3-feet (minimum) of the ground surface, to prevent damage from freezing.

The diameter of the mill shall be based on the stroke length of the pump rod and the average wind speed. Arizona annual average wind power classes can be obtained from Wind Energy Resource Atlas of the United States. Towers shall be proportioned to the mill diameter, with adequate height for efficient and safe operation.

#### **Water powered pumps (hydraulic rams).**

Pumping units shall be sized according to flow rate, lift, fall, and efficiency. Bypass water shall be returned to the stream or storage facility, without erosion or impairment to water quality

**Electric Submersible Pump.** Electric submersible pump and motors shall be installed per manufacturer recommendations and shall meet the following minimum criteria:

- Pump shall have stainless steel, plastic or bronze impellers;
- Motor shall be a 220-volt, 60-hz, single or triple phase, meeting NEMA Standard MG1;
- The power cable (conductor) shall be new neoprene-jacketed vulcanized submersible pump cable, with insulation (Type RHW, rugged heavy wall) bonded to the conductor.
- Conductor shall be sized to limit the voltage drop to less than 3-percent at the motor terminals, and not less than American Wire Gauge (AWG) No. 12.
- Pressure switches shall be Square D company or equal;

- Drop pipe shall be galvanized steel, reamed and threaded, meeting ASTM A53 or polyvinyl chloride (PVC) 1120 or Schedule 80, conforming to ASTM D1785, or HDPE conforming to ASTM D2239 unless otherwise specified.
- Check valves (Danfoss Flowmatic No. 80 or equal) shall be installed per manufacturer recommendations;
- Torque Arrestors (Harvard TA 48 or approved equal) shall be installed just above the pump.

**Pump Jack.** Pump Jack units shall be installed per manufacturer or installer recommendation and shall meet the following minimum criteria:

- Enclosed, non-worm gear;
- Pump or sucker rod shall be a ¾-inch, hollow or solid, galvanized steel rod or a 5/8-inch fiberglass rod with integral couplings;
- Drop pipe shall consist threaded galvanized pipe meeting ASTM A53;
- The well cylinder assembly shall be an open-top, brass-lined galvanized or brass cylinder and shall include a three or four plunger with a single or double leather check, both with matching stainless steel or brass ball valves;
- The polished rod assembly shall include a ¾-inch polished steel core rod, with a 24-inch stroke length brass or steel polished rod sleeve;
- An automatic bleeder orifice valve shall be installed in the drop pipe within 3-feet (minimum) of the ground
- Electric motors will not be specified or used on pump jack installations.

**Suction and discharge pipes.** To prevent cavitation, suction and discharge pipes shall be designed to account for suction lift, net positive suction head, pipe diameter and length, minor losses, temperature, and altitude. The size of suction and discharge pipes shall be based on hydraulic analysis, operating costs, and compatibility with other system components.

Appurtenances such as gate valves, check valves, pressure reducing valves, pressure gages, pipe connections, and other protective devices, shall be included to meet the requirements of the application. *The following components or appurtenances are required on all pump discharge pipes where detrimental backflow may occur (i.e., lift situations and back flow prevention), unless a detailed hydraulic analysis, including surge considerations, is performed and clearly documented for all operating conditions or situations:*

- A “non slam” type or solenoid operated check valve to prevent backflow through the pump and motor and containments from entering the a water supply or storage facility;
- A shutoff or isolation valve to allow maintenance or control measures;
- A pressure-relief valve (PRV) shall be installed on the discharge side of the check valve to protect the system against hydraulic transients (water hammer);
- A air release and vacuum relief valve (AVR) shall be installed to allow air entry (vacuum protection) and release from the line upon filling and draining, sudden valve closure or pump shutoff;
- A continuous acting air release valve (CAV) may be used in lieu of an AVR, if needed to provide a means for air removal from the system when in operation (summit or high point in system).

Screens, filters, trash racks, or other devices shall be installed as needed to prevent the intake of sand, gravel, debris, or other objectionable material into the pump. Intake screens shall be designed according to applicable Federal and State guidelines, to avoid entrainment or trapping of aquatic organisms.

Backflow prevention devices shall be included according to Federal, State, and Local laws, to prevent contamination of water sources connected to the pumping plant *and shall be installed when pumping from wells, domestic water sources or when chemigating.*

*All above ground pipes and components that will be exposed to sunlight shall be galvanized steel, steel or HDPE and shall meet applicable Arizona Material specifications. PVC pipe may be allowed, if recommended by the pump manufacturer and pipe is protected (paint, wrap) from sunlight, refer to Conservation Practice 430 – Irrigation Pipeline for approved coverings. Plans shall clearly document the type and extent of protective measures to be provided.*

**Building and accessories.** Pumps shall be securely mounted on a solid foundation such as structural steel, treated timber, pilings or reinforced concrete. Foundations shall be designed to safely support the loads imposed by the pumping plant and appurtenances, *including the vibrations from the pump motor.* Sheet piling or other measures shall be used, as required, to

prevent piping beneath the foundation. *The following criteria shall be met:*

- *Exposed steel surfaces shall be protected from corrosion by galvanizing, painting, or other approved coatings,*
- *All lumber in contact with the ground shall be pressure treated and conform to the requirements of applicable American Wood Preservers' Association (AWPA) standards and specifications.*

Where buildings, housing or covers are necessary to protect the pumping plant to protect the equipment from the elements [i.e., rain and sun], vandalism, or fire, provisions shall be included for adequate ventilation and accessibility for equipment maintenance, repairs, or removal. *The housing or cover shall be constructed from durable materials (lumber, concrete block, etc.,) shall allow for air movement and ventilation and positioned to protect the motor from the midday to late afternoon sun. The appearance of the pumping plant enclosure shall be compatible with the surrounding environment, as applicable.*

Suction bays or sumps shall be designed to prevent the introduction of air at the intake. *Trash racks shall be provided, as needed, to exclude debris and trash from the pump.*

The discharge bay or the connection to the distribution system shall meet all hydraulic and structural requirements.

Structures and equipment shall be designed to provide adequate safety features to protect operators, workers, and the public from potential injury *and shall comply with local building codes.* Drive shaft covers shall be required on all exposed rotating shafts *to minimize inadvertent contact.*

#### **Additional Criteria Applicable to Providing the Efficient Use of Water on Irrigated Land**

Provisions for the connection of flow and pressure measurement devices shall be included in power plant system design.

#### **Additional Criteria Applicable to the Improvement of Air Quality**

Replacement pumping plants shall have lower total emissions of oxides of nitrogen and fine particulate matter, compared to the unit being replaced.

New, replacement, or retrofitted pumping equipment shall utilize a non-combustion power source, or cleaner-burning technologies or fuels.

#### **Additional Criteria Applicable to Reduce Energy Use**

For fossil fuel or electrical grid power sources, pumping plant installations shall meet or exceed the Nebraska Pumping Plant Performance Criteria. Refer to the NRCS National Engineering Handbook, Part 652, National Irrigation Guide, Table 12-2.

#### **Additional Criteria in Federally Listed, Proposed or Candidate Species' Habitat**

This practice is not likely to adversely affect listed species or their critical habitat if the following conservation measures are implemented. Non-implemented measures require additional effect determination.

- Use existing stream crossings for equipment access during practice installation.
- Minimize soil and vegetation disturbance during practice installation. Remove only targeted species and leave native herbaceous layer undisturbed to allow for regrowth.
- Immediately clean any grease, oil, or other contaminant spills and remove from the site.
- Runoff from installed impervious surfaces will not drain into adjacent listed species aquatic habitat.
- Avoid planting of non native plants in disturbed areas. NRCS will consult with FWS if the planting of non native plants is unavoidable.
- Minimize upland soil compaction during practice installation by scheduling installation during dry periods.
- Use existing roads and limit cross country travel.
- Where clearing of vegetation is determined to be necessary during planned construction or maintenance, limit the width of clearance to 25 feet maximum.
- Disturbed area around construction pads shall not exceed 25 feet beyond outside edge of pad.
- Flag individuals of a listed plant species for protection during construction.
- Do not demolish or remove existing vegetation, habitat structures, covers or nest materials located within a 250 feet wide undisturbed buffer.

- Complete practice outside the periods considered as critical for the covered species.
- Alignments for planned construction (pipelines, fences) will be routed so as to avoid specific areas known to be occupied by listed species and known habitat features such as burrows and nests.
- Provide wildlife safe ingress/egress in trenches (ladder or dirt plugs to allow escape).
- Conduct a pre-installation, pedestrian survey for wildlife that may be trapped within a temporarily fenced construction area. Trapped wildlife will be allowed to escape prior to construction.
- Screen inlets and outlets to prevent non-native fish and amphibians from spreading into other habitats.
- Reduce spread of non-native plants or animals by implementing the practice during the dormant season (e.g. avoid ground disturbance in riparian areas in the summer to reduce salt cedar spread).
- Clean equipment used in practice implementation (vehicles, farm equipment, and tools) before entering and leaving project site to prevent the spread of non-native plant/animals or disease.

**Testing.** *A field test verifying that the pumping plant performance meets system design criteria must be completed prior to approval and acceptance of the system. There will be no objectionable flow conditions. Any leak shall be repaired and the system retested.*

### **Investigations, Surveys and Design**

**Criteria.** *Minimum documentation requirements for this practice are outlined under this section. Documentation for associated practices or system components shall follow their applicable practice standards and requirements.*

*Conduct a preliminary site assessment or investigation to determine the complexity of the problem, the need and feasibility of the pumping plant, and the location of power sources, if applicable, and may include:*

1. *Determine the water source, quality, quantity and availability.*
2. *Determine the type of pump (axial flow, centrifugal, etc.) that would be applicable to the project (i.e., irrigation, livestock, drainage, etc.).*

3. *Soils and geological investigation. Consider soil types, characteristics, depths, topography, water table, inhibiting layers, seepage rates, etc.*
4. *Verify appropriate state or local laws for permitting (i.e., well installation, backflow prevention, water rights, etc.) and approval requirements and notify landowner of his/her responsibilities.*
5. *Verification or certification of used materials (if any).*

*To adequately plan and layout this practice, a detailed topographic survey is required, that adequately details:*

1. *The location of the proposed pumping plant and any structures that may interfere with its installation.*
2. *All critical or control elevations (topographic survey of system) and pertinent water surface elevations for both surface and subsurface applications and location of underground or overhead utilities or markers.*
3. *If applicable, a permanent benchmark(s) shall be set and described. Preferably, the elevations and coordinates should be based on a local (assumed) or coordinate system (State or grid) and clearly stated on the plan. Datum may be in the form of Northing and Easting coordinates, or Longitude and Latitude.*

*Where applicable, USGS 7.5-minute topographic Quadrangles may be used, provided hydraulic analysis verifies minimum criteria are met at all locations.*

*The design of a practice is the application of Field Office Technical Guide practice standards, NEH Part 651, AWMFH, using experience and judgment in the development of a solution to the problem or the objective. All computations and decisions made during the design of a practice are to be checked by another qualified individual and appropriate notations made. Design computations, calculations or analysis shall meet the following criteria:*

1. *Determine the pump requirements (i.e. capacity [gpm] and total dynamic head [feet]) required or the pump discharge pressure when the pumping life is not readily available (i.e., determine the minimum and maximum design: flow capacity operating ranges; pumping levels or lifts; operating pressure head);*

2. *Net Positive Suction Head Calculation (NPSH<sub>A</sub> versus NPSH<sub>R</sub>), primarily for centrifugal pump installations;*
3. *Determine the pump/motor efficiencies, nominal pump size, number of pumps and/or stages, impeller trim size (as applicable);*
4. *Suction and Discharge pipe requirements, i.e. material types, nominal diameters (outside or inside diameters), wall thickness or pressure rating, connection types;*
5. *Appurtenances and/or components: gates, valves, pipe connections, screens and/or filters, discharge and inlet bays, flow measurement, etc.*
6. *Power unit type and requirements.*
  - i. *Electric motor (i.e., electric submersible): single or 3-phase, brake horsepower capabilities within all pump operating ranges or conditions, voltage or amperage requirements, and safety or shutoff appurtenances;*
  - ii. *Pump Jack and Windmill: manufacturer, pump or sucker rod diameter, drop pipe, well cylinder assembly, polished rod assembly, automatic bleeder valve;*
  - iii. *Combustion Engine: type (diesel, propane, natural gas, etc.), brake horsepower capabilities within all pump operating ranges or conditions, and safety or shutoff appurtenances;*
  - iv. *Photovoltaic: PV module size and number, amperage and voltage characteristics, service life/warranty, mounting requirements, solar trackers, batteries and lightning protection, as applicable.*
7. *Electrical panel requirements (type, load capacity, starting/shutoff switches, protective covers, and safety or overload shutoff devices;*
8. *Building and accessories (design details of structural components, including computations and analysis), vibration control, foundation stability, anchoring, safety, etc.;*

**Installation and Basis of Acceptance.** *For construction that does not meet State, OSHA, or Tribal criteria or requirements where deficient construction materials were used, NRCS may consider a waiver request for approval of construction after it has received a signed and sealed construction and/or material exemption from a licensed engineer. Required exemption shall be for installation of materials that do not meet minimum quality criteria as found in*

*applicable Standards, Specifications, ASTM's, AWWA standards, etc.*

*Contractors performing work under this practice shall abide by all Federal, State or Tribal laws or criteria, and must be licensed by the state board of technical registers where the work is being implemented.*

## CONSIDERATIONS

When planning this practice the following items should be considered, as applicable:

- The removal of surface water by a pumping plant can affect downstream flows or aquifer recharge volumes. Consider potential the long term impacts downstream of the pumping plant.
- If using a pumping plant to remove surface water or ground water flowing into a wetland, consider the potential impacts on existing wetland hydrology.
- The operation and maintenance of a pumping plant can involve the use of fuels and lubricants that when spilled may adversely affect surface or ground water quality. Consider measures to protect the environment from potential spills. In some cases, secondary containment of spilled fuel may be required by Federal and State laws or regulations.
- Pumping plants are often constructed in flood-prone areas or can be subject to other unexpected natural events. Consider how the pumping plant may be protected from extreme natural events and the consequences of damage or failure.
- Include protective sensors to detect low or stopped flow (*high/low switch*), or pressures that are too high or too low *to protect the pump, motor and system from any fluctuations in the water supply.*
- The visual appearance of buildings or structures associated with the pumping plant should be compatible with the surrounding environment.
- When installing new or replacing existing combustion equipment, non-combustion and renewable energy sources, such as solar, wind, and water, should be considered.
- *Consider pump type and size prior to sizing the well casing diameter for a new well to assure adequate space in the casing for the pump and related appurtenances.*
- *Consider remoteness of the site, frequency of maintenance inspections, economics, and*

importance of water supply for designing the pumping plants and water storage requirements.

*Design alternatives presented to the client should address economics, ecological concerns and acceptable level of risk for design criteria as it relates to hazards to life or property.*

**Flow Measurement.** A water measurement device or structure (flow meter, ramp flume, weir, etc.) may be installed to manage water applications and for on-going evaluation of system performance. Manufacturer's recommendations or sound engineering guidance must be followed regarding size, placement, orientation, etc.

## PLANS AND SPECIFICATIONS

*Use Arizona Standard Drawings and Construction and Material Specifications to the extent possible. Fill in blanks and add or delete items from the drawings and/or specifications to make them fit the job as needed. Additional drawings and /or specifications may need to be developed to provide full material and installation instructions.*

*Construction plans shall include all components needed for the safe operation of the proposed improvements such as railing, fencing, or warning signs as appropriate. The plans shall address operations near existing utilities, trench excavations and any other items related to construction of the structure that may pose a safety risk to those involved.*

*Development of plans and specifications for constructing pumping plants will be guided by the National Engineering Handbook, Part 650, the Engineering Field Handbook, Chapter 5, and shall be in accordance with the National Engineering Manual, Parts 541 and 542, shall be prepared for each specific field site, and shall be in accordance with this standard and good engineering practice and describe the requirements for properly installing the practice to achieve its intended purpose. As a minimum, the plans and specifications shall include the following:*

- *Project location map, including section, township and range, North arrow, cooperator/owner acknowledgement and certification signature blocks, engineering job class (cover sheet);*
- *References that the owner/cooperator are responsible for all permits, rights-of-way,*

*easements and the contact, coordination and location determination of any existing utilities or clearances (buried utility disclaimer);*

- *If applicable, a plan view or map showing the location of the pumping plant in relationship to other structures or natural features and in reference to a known or established benchmark or reference point with the location, description and elevation clearly shown. Topographical features and/or controls shall be shown, showing tie in with existing or other planned practices, if applicable.*

- *Field surveys and notes or soil investigations locations and soil classifications (foundation materials) and material estimates/quantities, if applicable.*

- *System overview and layout (i.e., water source; pump location; size and type of pump; pump discharge capacity [gpm] and required head [feet]; location of all system components; stationed profile along the centerline of the pumping plant system to the outlet point showing original ground line, pump intake and outlet requirements; screens, connections, valves and required appurtenances; minimum and maximum hydraulic gradelines and maximum static pressure; show cathodic protection details, if applicable; construction/installation criteria; State and Federal [OSHA] safety requirements).*

- *Details for mounting the pump (may be left to the manufacturer); plan and sectional views of the pump pad, foundation and/or anchors, including dimensions, type of material, etc. Plan and sectional views of the housing, cover or shading of the pump and control panel.*

- *Electrical details or requirements, including safety shields, warning signs, and necessary shutoff devices.*

- *Construction notes and/or detail drawings of the pumping plant and appurtenances, such as piping, inlet and outlet connections, mounting, foundations, and other structural components, as required, for proper system functionality.*

- *Table of quantities.*

- *Written specifications that describe the site specific details of installation. Use Arizona Construction and Material Specifications for each item of work and material, as applicable and available. Additional specifications may need to be written to provide full material and installation instructions. Fill in blanks and add or delete items from the specifications to make them fit the job as needed.*



*All designs completed by non-NRCS personnel shall meet minimum State licensing board requirements and NRCS requirements and criteria as outlined in the General Manual, the National Engineering Manual (including Arizona Supplements), and the National Engineering Handbook.*

**ONCE ALL PARTIES HAVE ACCEPTED AND SIGNED THE PLANS AND SPECIFICATIONS, NO CHANGES SHALL BE MADE TO THE DRAWINGS OR SPECIFICATIONS WITHOUT PRIOR APPROVAL OF NRCS.**

## **OPERATION AND MAINTENANCE**

An Operation and Maintenance plan specific to the pumping plant being installed shall be prepared for use by the landowner, cooperator and/or responsible operator, and shall be commensurate with the size and complexity of the project. The plan shall document needed actions, including reference to periodic inspections and the prompt repair or replacement of damaged components, and provide specific instructions for operating and maintaining facilities to ensure the pumping plant functions properly as designed throughout its expected life.

O&M requirements shall be determined as part of the design and should be documented as brief statements in the plans, the specifications, the conservation plan narrative, or as a separate O&M plan. As a minimum, the plan shall address the following:

- Inspection, maintenance or testing of all pumping plant components and appurtenances (valves, piping, floats, drains), as applicable.
- Proper start-up and shut-down procedures for the operation of the pumping plant.
- Routine maintenance of all mechanical components (power unit, pump, drive train, etc.) in accordance with the manufacturer's recommendations.
- Procedures to protect the system from damage due to freezing temperatures.
- When applicable, procedures to frequently check the power unit, fuel storage facilities, and fuel lines for fuel or lubricant leaks and repaired as needed.
- Periodic checks and removal of debris as necessary from trash racks and structures, to assure adequate flow capacity reaching the pumping plant intake.

- Periodic removal of sediment in suction bays, to maintain design capacity and efficiency.
- Inspection and maintenance of anti-siphon devices, if applicable.
- Routine testing and inspection of all automated components of the pumping plant to assure the proper functioning as designed.
- Inspection and maintenance of secondary containment facilities, if applicable.
- Periodic inspection of all safety features to ensure placement and function.
- Prior to retrofitting any electrically powered equipment, electrical service must be disconnected and the absence of stray electrical current verified.
- *Eradicate or otherwise remove all rodents or burrowing animals that have or may potentially damage any part of the delivery or application facilities. Immediately repair any damage caused by their activity;*
- *Immediately repair any damage resulting from vandalism, vehicles, livestock or wildlife;*
- *Protect all pumps and piping including valves that are subject to freezing. If parts of the system cannot be drained, a non-corrosive anti-freeze solution shall be added. If the system is not operated in the winter, surface pumps, intake pipes, and discharge pipes should be drained to prevent damage from freezing.*
- *Keep accurate, detailed records. The records should include, at a minimum, energy consumption, and variations in noise and vibrations. Records should also include flow rate and pressure at the pump, if available.*
- *Check all pump bases and mountings regularly for durability and ability to hold the pump in place without vibration; repair when necessary. Check and tighten all bolts on the mounting structure as needed.*
- *All individual manufacturers operating and maintenance instructions shall be attached to the O&M plan upon completion of the job.*
- *Maintain grounding rods and wiring of all electrical equipment in good working condition.*
- *Provide and maintain adequate surface water drainage around the pumping plant area.*
- *Consult with the manufacturer and professional services for problems that require major work, wiring, advanced skills or equipment. Check if the problem is covered by pump warranty.*
- *Replace, repack, or tighten the seals when leakage is in excess of manufacturer's recommendations. Check seals, piston cup*

leathers, piston rod seal and foot valve for wear and replace as necessary.

- Check the tightness of all electrical connections in the system. Check for exposed wires and cracks or breaks in the insulation. Replace as necessary.

Any problems discovered shall be immediately repaired.

### **Windmills**

- Disable the wind pump before working on it by activating manual furling mechanism and applying the brake.
- For any operation involving climbing the tower, use of a safety line is required.
- Drain the oil in the gear case and fill with proper oil according to the manufacturer's recommendations. Oil the turntable and the furl ring once a year.
- To service the pump, seals and piston, they must be removed from the borehole.
- Check and adjust the furling mechanism tension to a lighter setting initially when installed. It can be tensioned when it runs and furls effectively.
- Check, tighten, and lubricate the moving parts according to the manufacturer's recommendations
- Replace worn bearings, rotor blades and other parts as necessary.
- Inspect the wind pump annually at welded and bolted joints for cracks. Retighten or weld cracks.
- Paint the wind pump periodically to prevent corrosion.

### **Pump jack**

- Follow safety procedures and manufacturer's recommendations related to servicing of the pump jacks to reduce the chance of fall, overhead, and being struck-by hazards during maintenance and servicing or removal to access the wellhead.
- Check to ensure that the pump jack head is tightened, locked and/or latched securely in place with jack screws and clamp bolt.
- Change the oil in the pump jack gear box according to the manufacturer's recommendations.

### **Photovoltaic (PV) powered pumping systems**

- Check the manufacturer's recommended maintenance procedures for all batteries. Check

the electrolyte level and specific gravity of each cell in the battery.

- Trees, shrubs and other vegetation may be trimmed to keep the PV array clear of shading. Clean the dust and debris off the solar panels with water as recommended by the manufacturer.
- PV-powered pumping systems require periodic replacement of filters, diaphragms, piston seals, cylinder leathers, or DC motor brushes depending on the type of pump.
- If a tracker is included in the system, the pivots should be lubricated once a year. The pivot points and tracking mechanisms should be inspected for dust, rust and painted as required.

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